U. S. Department of Energy
Federal Energy Technology Center
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880

626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940

INFORMATION PACKAGE
DE-RA22-97BC15017
ADVANCED RECOVERY CONCEPTS FOR OIL EXTRACTION

1. FOREWORD

The research areas and objectives of Program Research and Development Announcement (PRDA) No. DE-RA26-97BC15017 entitled "Advanced Recovery Concepts for Oil Extraction" are being released in **draft form** to provide an opportunity for potential offerors to review and become familiar with the requirements. Official release of the entire solicitation is anticipated on or about May 13, 1997, with proposals being due approximately July 15, 1997.

The DOE will consider all timely comments submitted on the information contained herein but makes no guarantee that any comment or group of comments will result in identifiable changes to the solicitation. **Comments should be submitted to Ms. Donna Lebetz via Internet at "lebetz@fetc.doe.gov" no later than April 30, 1997.**

Note that the DOE is under no obligation to respond to individual comments or questions, nor is it responsible for any costs associated with future proposal preparation.

2. PRDA OBJECTIVES

The Department of Energy's (DOE) National Petroleum Technology Office (NPTO) seeks basic research proposals on advanced and innovative technology which will substantially increase predictability and improve Advanced Recovery Concepts for oil extraction. The general objective of this Advanced Recovery Concepts PRDA is to support fundamental research to reduce or eliminate the barriers to economically attractive, predictable, applications of advanced recovery concepts in the following four (4) areas: 1) Gas Flooding; 2) Chemical Flooding; 3) Microbial Flooding; and 4) Simulation of these processes. The proposals should focus on increasing oil recovery using Advanced Recovery Concepts. The solicitation does not seek proposals which either duplicate current research efforts or offer only minor improvements in process performance or process predictability.

3. BACKGROUND

The primary mission of the Fossil Energy (FE) program is to conduct the coal, petroleum, and gas research and development programs of the Department of Energy (DOE). The program will expand the knowledge base which, with industry, can bring efficient, economically competitive, and environmentally acceptable new fossil energy resources and technology options into the marketplace and improve the United States national security by reducing dependence on imported oil. As an integral part of the FE mission and strategy, Extraction Research is directed toward the development

of advanced and innovative technologies for recovering oil from large, currently unrecoverable petroleum resources.

The DOE focuses oil-related research into three time frames: near-term, mid-term, and long-term. Each time frame has specific objectives related to the types of recovery that can be applied and to the type of resources being exploited (Oil Research Program Implementation Plan, April 1990, DOE/FE-01088P).

The **goal** is to "**maximize the economic producibility of the domestic oil resource.**" The three time-specific, strategic **objectives** are:

1. In the **near-term** (within five years), preserve access to reservoirs with high potential which are rapidly approaching their economic limits.

2. In the **mid-term** (within ten years), develop, test, and transfer the best, currently defined advanced technologies to operators of the reservoirs with the greatest potential for incremental recovery.

3. In the **long-term**, develop sufficient fundamental understanding to define new recovery techniques for the oil left after the most advanced, currently defined mid-term processes, and for major classes of reservoirs for which no advanced technologies are anticipated to be available in the mid-term.

As an integral part of the Fossil Energy mission and strategy, the extraction research of oil is directed toward the development of advanced and innovative technologies for recovering oil from large, currently unrecoverable, petroleum resources. Primary and secondary recovery operations have been utilized for many years to extract oil from reservoirs. A DOE study estimated that 256 billion barrels of oil remain in place in known U. S. oil resources (Federal Oil Research: A Strategy for Maximizing the Producibility of Known U.S. Oil, DOE/FE-0139, August 1989).

With continually diminishing U.S. crude production and increasing dependency on foreign supplies, there is a need to develop oil production from these domestic oil resources. Advanced Recovery Concepts will play a significant role in the exploitation of these domestic resources. New techniques to overcome the problems associated with advanced recovery are needed in order to meet the energy demands of the immediate future. The importance of increasing the petroleum reserves of the United States through the production of oil left in petroleum reservoirs after conventional recovery techniques are used is well known and well documented.

4. GENERAL PROJECT APPROACH

PRDA No. DE-RA26-97BC15017 will mainly address the **mid-term** and **long-term** portion of the DOE policy. In part, this solicitation is designed to identify research opportunities and conduct research (and transfer the results of such research to the user community) in the extraction of domestic petroleum resources which are not being pursued by the private sector because of high-risk/long-term considerations. The PRDA is intended to provide an offeror with maximum

opportunity in structuring the research tasks in a research plan with appropriate milestones and a statement-of-work (SOW) that will suit the subject area and the state of knowledge or development in that area. Where a multi-phase research program is envisioned, the offeror must define the various stages in each phase, and the technical criteria for determining successful completion of each stage before advancing to subsequent stages.

It is contemplated that experimental research tasks in the selected research areas of interest, as a minimum, will achieve: development or improvement of the cost effectiveness of gas flooding, chemical flooding, and microbial methods; development or improvement of laboratory scale experiments/measurements and/or theoretical studies of gas flooding processes, chemical flooding processes, microbial flooding processes, and process simulation in pertinent areas such as heterogeneity and core flooding via physical and mathematical modeling applicable to reservoir/process simulation; collection and reduction of experimental or analytical data showing the performance, effectiveness, and significance of the laboratory and theoretical results; and preparation and delivery of technical reports (quarterly, annual, final) showing the results of the project, including details of all relevant performance characteristics and techniques by which they were calculated. Detailed specification of performance characteristics, their technical significance in Advanced Oil Recovery (AOR) systems, their potential economic significance, and the recommendations for further research shall be documented.

5. PRDA PROGRAM AREAS OF INTEREST

Proposals for Advanced Recovery Concepts will be considered in any of the following four (4) areas: 1) Gas Flooding; 2) Chemical Flooding; 3) Microbial Flooding; and 4) Simulation of these Processes.

5.1 Gas Flooding

One of the major challenges to improving the oil recovery from carbon dioxide flooding is to reduce the amount of oil bypassed due the poor sweep of carbon dioxide. Past work on mobility control for carbon dioxide flooding using foams, polymers and direct thickeners has shown promise, but has not yielded a widely accepted method. The improvement in sweep for carbon dioxide floods remains a major challenge. The ability to conduct carbon dioxide floods, natural gas floods or nitrogen floods effectively below the miscibility pressure would greatly increase the use of these processes in shallow oil reservoirs. Note that the term “gas flooding” for this PRDA does not include using gas for pressure maintenance or repressurization.

5.2 Chemical Flooding

Proposals are sought for developing low cost surfactants for use in surfactant flooding (surfactant-polymer, micellar-polymer, low tension flooding, alkaline-surfactant-flooding). Surfactant flooding involves injection of a chemical that is partially oil-soluble and partially water-soluble. These molecules migrate to the oil-brine interface and lower interfacial tension between the reservoir oil and water. This minimizes capillary forces and mobilizes oil that would otherwise be trapped by the reservoir water. The factors necessary to reduce adsorption of surfactant on reservoir rock and/or

interaction with divalent ions has been clarified. However, the factors that affect low interfacial tension do not coincide with those that affect low adsorption. Some guidelines have been established for balancing these competing factors and emphasizing the favorable molecular structure of the surfactant. The potential of pretreatment of the reservoir (preflushing, wettability alteration, etc.) has been addressed, but this area needs further research.

Proposals are sought for the development of low cost polymers for use in polymer flooding (Polymer, Gels, Sweep Improvement, Profile Modification, Reservoir Conformance). Polymer flooding is an augmented water flood that uses synthetic or biologically produced polymers to thicken the injected water and increase its viscosity relative to that of the reservoir fluids, thereby improving recovery efficiency. The intended improvement in sweep efficiency is due to restriction of higher permeability channels by the polymer solution. This directs the injectant into previously unswept zones and improves mobility control. Areal sweep can be improved by upgrading mobility control. Volumetric sweep can be improved by fluid diversion techniques that effectively reduce macro-heterogeneities of the reservoir. Polymers may also be used to improve reservoir conformance and sweep efficiency. The problem of reservoir conformance is considered to be important enough that the Society of Petroleum Engineers in August, 1988, and August, 1993, devoted an entire Forum to this problem. The concept is to control the injection and produced fluids in such a manner that the oil production is enhanced. Therefore, if the oil saturation is low in a particular area of the reservoir, it would be advantageous to have the EOR process not enter that region but rather into a region having higher oil saturation. Polymer gels are currently being used to improve conformance and profile modification.

5.3 Microbial Flooding

Microbial flooding methods have a high potential for recovering oil. These methods hold promise as an application for independent oil producers. There is currently only one project shown by the April 15, 1996, EOR Survey and Analysis conducted by the Oil and Gas Journal. Microbial methods have been used in environmental cleanup projects; however, like surfactant flooding (micellar-polymer), microbial flooding methods have not been used on a large scale for oil recovery. Increased research is needed if these methods are to make a major contribution to oil recovery. Methods of using microbes to make cost-effective surfactants or finding microbes, which can be used to produce oil must be found to make microbial flooding methods more attractive to the oil producer.

Microbial flooding techniques consist of injecting microbes into the reservoir, thereby generating surfactants, gas, or polymers, which will increase the oil recovery. Note that the use of microbial techniques for the reduction of an environmental problem is not acceptable for this PRDA unless it relates directly to oil recovery. For example, microbial methods which can generate low cost surfactants or polymers at the surface, especially from waste products, are acceptable areas of research.

5.4 Advanced Recovery Simulation

The PRDA does solicit proposals to develop new or to make major extensions to "mainframe or supercomputer" simulators. Also, scaled down simulators are required which are adequate for

"desktop" or "workstation" systems that would be beneficial to the smaller oil producer. It is important to note that the simulator source code, executable files, and appropriate manuals shall be required to be made available to the public through DOE publications.

6. LEVEL OF EFFORT

It is expected that the effort needed for each project will range from $150-300K per contract, per year, depending upon the level of development of the particular concept being proposed.

7. CONTRACT TYPE

The DOE anticipates making multiple awards via cost-sharing contract(s). **The participant must cost share at least 20 percent of the total allowable cost.** For example, if the total cost is $100,000, the participant must share at least $20,000 and DOE's share will be no more than $80,000.

8. PROPOSAL PREPARATION

Proposals should be prepared simply and economically, providing a straight forward and concise description of the capabilities proposed to satisfy the requirements of this PRDA. Emphasis in the proposal should be on completeness and clarity of content. NOTE that page limitations will be prescribed in the solcitation document, as well as guidance as to submission of technical, cost, environmental and other data. The DOE is not responsible for any costs associated with proposal preparation.

9. RELEASE OF ENTIRE SOLICITATION

As noted above, it is anticipated that PRDA No. DE-RA26-97BC15017 will be **accessible** (as a Word Perfect 6.1 (Windows) document or in the Portable Document Format (PDF)) on the World Wide Web (WWW) **at http://www.petc.doe.gov/business.html** (select "solicitations") on or about **May 13, 1997**, and that the closing date for submission of proposals will be on or about July 15, 1997. Those who obtain a copy of the solicitation through the WWW should **check the location frequently for any amendments**.